

[0021] FIG. 7 shows a plan view of an exemplary multi-lane microfluidic cartridge;

[0022] FIG. 8 shows an exemplary microfluidic network in a lane of a multi-lane cartridge;

[0023] FIGS. 9A-C show a layer structure of an exemplary microfluidic cartridge;

[0024] FIGS. 10A-C show exemplary configurations of microfluidic valves;

[0025] FIG. 11 shows an exemplary highly-multiplexed microfluidic cartridge;

[0026] FIGS. 12-15 show various aspects of exemplary highly multiplexed microfluidic cartridges; and

[0027] FIGS. 16A-C show various aspects of a radially configured highly multiplexed microfluidic cartridge.

[0028] FIGS. 17A-17C shows various cut-away sections that can be used to improve cooling rates during PCR thermal cycling;

[0029] FIG. 18 shows a plot of temperature against time during a PCR process, as performed on a microfluidic cartridge as described herein;

[0030] FIG. 19 shows an exemplary layout for electronics and software components, as further described herein;

[0031] FIG. 20 shows an exemplary apparatus, a microfluidic cartridge, and a read head, as further described herein;

[0032] FIGS. 21-23 show positioning of a cartridge in an exemplary apparatus;

[0033] FIGS. 24 and 25 show removal of a heater unit from an exemplary apparatus;

[0034] FIGS. 26A and 26B show an exemplary heater unit and heater substrate;

[0035] FIGS. 27-29 show an exemplary heater substrate and heater unit;

[0036] FIGS. 30A-30C show an exemplary heater configuration to heat a PCR chamber; and

[0037] FIGS. 31A-31F show aspects of heater element fine structure.

DETAILED DESCRIPTION

[0038] The present technology comprises a heater unit that is configured to apply heat selectively to a microfluidic substrate for the purpose of carrying out an amplification, such as by PCR, of one or more polynucleotides from one or more samples present in the substrate. It is to be understood that, unless specifically made clear to the contrary, where the term PCR is used herein, any other form of polynucleotide amplification is intended to be understood. By apply heat selectively is meant that the heat may be applied to one or more specific locations on the cartridge and at controlled times. Thus certain locations may be heated contemporaneously, such as simultaneously, and other locations may receive heat at different times from one another.

[0039] The microfluidic substrate is designed so that it receives thermal energy from one or more heating elements present in the heater unit described herein when it is in thermal communication therewith. A substrate may be part of a cartridge.

[0040] By cartridge is meant a unit that may be disposable, or reusable in whole or in part, and that is configured to be used in conjunction with some other apparatus that has been suitably and complementarily configured to receive and operate on (such as deliver energy to via a heater module as described herein) the cartridge.

[0041] An exemplary such cartridge is further described herein; additional embodiments of such a cartridge are found

in U.S. patent application Ser. No. _____, entitled "Microfluidic Cartridge and Method of Making Same", and filed on even date herewith, the specification of which is incorporated herein by reference. The heater unit may be part of an apparatus, configured to receive the cartridge, and comprising other features such as control circuitry, user interface, and detector, as well as still other features. An exemplary such apparatus is further described herein; additional embodiments of such an apparatus are found in U.S. patent application Ser. No. _____, entitled "Microfluidic System for Amplifying and Detecting Polynucleotides in Parallel", and filed on even date herewith, the specification of which is incorporated herein by reference.

[0042] By microfluidic, as used herein, is meant that volumes of sample, and/or reagent, and/or amplified polynucleotide are from about 0.1 μ l to about 999 μ l, such as from 1-100 μ l, or from 2-25 μ l. Similarly, as applied to a cartridge or a substrate, the term microfluidic means that various components and channels of the cartridge, as further described herein, are configured to accept, and/or retain, and/or facilitate passage of microfluidic volumes of sample, reagent, or amplified polynucleotide.

[0043] One aspect of the present technology relates to a heater unit that is configured to apply heat selectively to a microfluidic substrate having two or more sample lanes arranged so that analyses can be carried out in two or more of the lanes in parallel, for example simultaneously, and wherein each lane is independently associated with a given sample.

[0044] A sample lane, as found in a microfluidic substrate that is heated by a heater unit herein, is an independently controllable set of elements by which a sample can be analyzed, for example by carrying out PCR on a sample in which the presence or absence of one or more polynucleotides is to be determined, according to methods described in, e.g., U.S. patent application Ser. No. _____, entitled "Microfluidic Cartridge and Method of Making Same", and filed on even date herewith. A sample lane comprises at least a sample inlet, and a microfluidic network having one or more microfluidic components, as further described herein.

[0045] In various embodiments, a sample lane of a microfluidic substrate can include a sample inlet port or valve, and a microfluidic network that comprises, in fluidic communication one or more components selected from the group consisting of: at least one thermally actuated valve, a bubble removal vent, at least one gate, at least one thermally actuated pump, a downstream thermally actuated valve, mixing channels, one or more positioning elements, and a PCR reaction chamber. The various components of the microfluidic network of each sample lane can be independently and selectively heated by the heater unit described herein.

[0046] Channels of a microfluidic network in a lane of a substrate typically have at least one sub-millimeter cross-sectional dimension. For example, channels of such a network may have a width and/or a depth of about 1 mm or less (e.g., about 750 microns or less, about 500 microns, or less, about 250 microns or less).

[0047] Particular components of exemplary microfluidic networks are further described in U.S. patent application Ser. No. _____, entitled "Microfluidic Cartridge and Method of Making Same" and filed on even date herewith.

[0048] In various embodiments, the microfluidic network can be configured to couple heat from an external heat source provided by the heater unit described herein to a sample mixture comprising PCR reagent and neutralized polynucle-